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Monitoring of hard coral covers and zonation of marine conservation area of Tuan Island, Aceh Besar District, Indonesia

[1]Nadia Aldyza, [2]Muhammad A. Sarong, [3]Syamsul Rizal

[1] Department of Biology Education, Graduate School of Syiah Kuala University, Banda Aceh 23111, Indonesia; [2] Department of Biology, Faculty of Teacher Training and Education, Syiah Kuala University, Banda Aceh 23111, Indonesia; [3] Department of Marine Sciences, Faculty of Marine and Fisheries, Syiah Kuala University, Banda Aceh 23111, Indonesia. Corresponding author: S. Rizal, syamsul.rizal@unsyiah.net

Abstract. The objective of this study was to monitor the hard coral covers and zonation of marine conservation area of Tuan Island Peukan Bada, Aceh Besar district. The study was conducted from March 16, 2014 to May 27, 2014. The coral data retrieval uses Point Intercept Transect Method. The coral condition was identified based on the criteria of coral cover, the analysis of coral cover using the formula of coral cover percentage. The results showed that the hard coral cover in the region of Tuan Island was 85%, consisting of 72.5% Acropora, 8.13% Montipora, 2.5% Pocillopora, 1.25% Porites and 0.63% Goniastrea. Based on this value, it is concluded that the coral reef condition in the Tuan Island is in excellent condition.
Key Words: Aceh Besar, Tuan Island, zoning, coral reef.

Introduction. Coral is one of the most diverse animal colonies and an important aquatic ecosystem economically and ecologically. However, the coral reef may degrade rapidly on a global scale because of a combination of pressures, including climate change, over-exploitation, coral disease and water quality changes (Hughes et al 2003; Bellwood et al 2004; Bruno & Selig 2007). In addition, coral stress is mostly caused by human activities, for example unfriendly fishing practices and sedimentation from agricultural and deforested areas (Halpern et al 2008).

Indonesia is known as the center of coral species diversity. The cover of coral reefs in Indonesia estimated 87,500 square kilometers or 14% of the overall from coral cover are in the worldwide. Acropora, Montipora and Porites is the most dominant genus found in Indonesian waters (Suharsano & Bruckner 2008) and coral species found in Indonesian waters is estimated as many as 590 species (Veron 2002). The Research Center for Oceanography-LIPI has conducted assessments of coral reef condition in numerous locations. The surveys showed that only 5.51% of Indonesian coral reefs in very good condition, 25.11% in good condition, 37.33% in moderate condition and 32.05 % in poor condition (Suharsano & Bruckner 2008).

Tuan Island is one of the locations covered by the reefs. The island is located in the Aceh Besar District, Aceh Province, Indonesia. This location is one of the marine conservation areas in Aceh province, that conservation area is establised in 2012. The preliminar study by Ocean Diving Club (2012) and Fadli et al (2014) showed that the dominant species of corals in Tuan Island are Acropora, Montipora, Pocillopora and Porites. Previous study in 2013 by The Ocean Diving Club, Syiah Kuala University showed that the coral covers was about 63.13%, but no updated data were available. Therefore, this is an important monitoring study in relation to provide a current status of coral reef in Tuan Island.

This study was focused on hard coral covers, because this coral was predominant in Tuan Island waters. As already mention early that Tuan Island has been designated as

marine protected areas; however the study on the conservation zoning patterns of coral reef ecosystems in Tuan Island has never been reported previously. Hence, the purpose of this study is to monitor the hard coral covers and zoning patterns of marine conservation area of Tuan Island, Aceh Besar District, Indonesia.

Material and Method

The location and the time of study. The study is conducted in Tuan Island Peukan Bada subdistrict, Aceh Besar district, at coordinate 05°33'50.9"N – 05°33'53.9"N, and 95°14'57.3"E – 95°15'01.2"E from March to May 2014, while the sampling site was done at coordinate 05°33'51.2"N and 95°15'00.2"E (Figure 1).

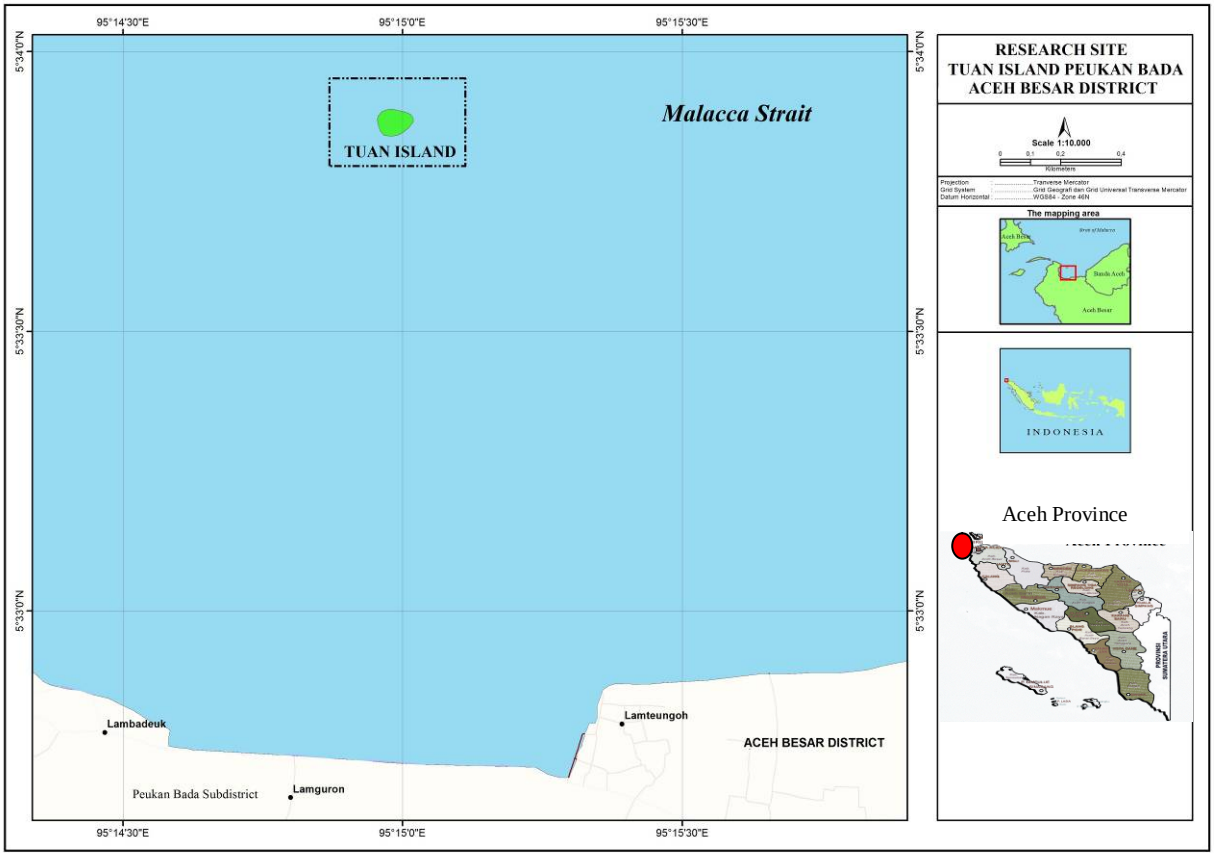

Figure 1. The map of Peukan Bada sub district showed the Tuan Island (in square).

Types and sources of data. The primary data were obtained from the direct observations at the study site and questionnaires, while the secondary data were obtained from research reports of local government and NGO, for example Lamjabat Foundation, WWF Indonesia and Jaringan KuALA. The targeted respondent is the community leaders that know deeply about the establishment in Tuan Island Peukan Bada, Aceh Besar district.

Coral data collection. The hard coral data were collected using Point Intersect Transect Method. The length of transect was 100 meters and the transect was divided into four segments and every segment has length 20 meters and separated by 5 meters intervals. The transects were placed parallel to the shoreline in shallow water (3-5 meters). The location of the transect at this depth is considered to represent the condition of reefs in Tuan Island (Fachrul 2007). While the data of zoning patterns were collected using documentary method. The physical condition of the waters were measured in situ; water temperature, water salinity, water transparency, and tidal height of the waters is measured every hour from 3:30 (in GMT) until 10:30 (in GMT).

Data analysis. The condition of coral reef was identified by criteria of hard coral cover, and analysis of coral cover in core zone using formula of coral cover percentage. Analysis of coral cover is using the formula (Rogers et al 1994) as follows:

$$\text{Percent of Cover} = (\text{Total Type Point}/\text{Total Point}) \times 100\%$$

The result of the percentage of coral cover was used to determine the condition of coral reef ecosystems. The condition of coral reef ecosystem was evaluated based on the criteria proposed by Gomez & Yap (1988) (Table 1).

Table 1

Criteria condition of coral cover (Gomez & Yap 1988)

Cover values (%)	*Criteria*
< 25	Poor
25–50	Fair
50–75	Good
> 75	Excellent

Results and Discussion

Hard coral condition. The study revealed that the corals covers of Tuan Island were 72.5% Acropora, 8.13% Montipora, 2.5% Pocillopora, 1.25% Porites and 0.63% Goniastrea, indicate that Acropora was a predominat hard coral in Tuan Island. In addition, the percentage of benthic covers were 85% hard corals, 10% rubbles, 1.25% rock, and 3.75% sand (Figure 2). This is an indication that hard coral cover was in excellent condition. Speed et al (2013) stated that the hard coral cover is the most widely used an indicator for the coral reefs condition in general.

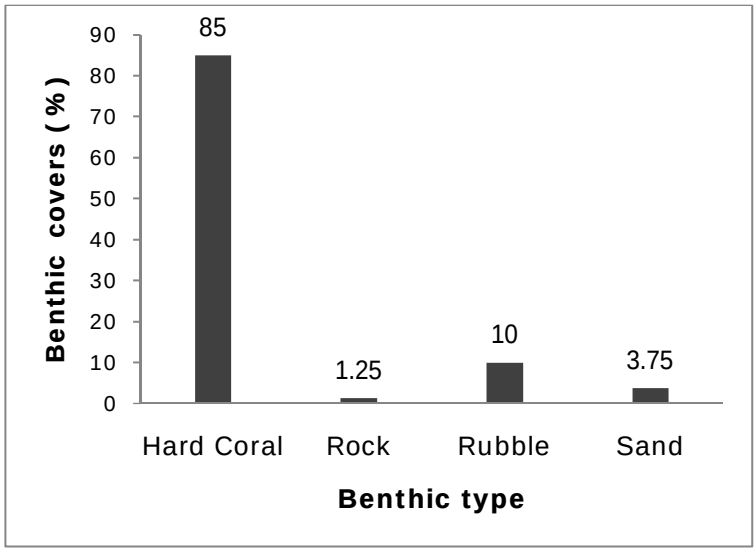

Figure 2. Percentage of benthic covers of Tuan Island recorded during the study.

The high percentage of coral cover was probably due to the decreases of fishermen activities in this area as a consequence of the establishment of conservation area since 2012 (Personal communication with fishermen leader of Tuan Island). Figure 3 shows that the percentage of coral covers after the establishment of conservation zones is higher than before the establishment of conservation zones in Tuan Island, for example the initial condition of coral cover was 33.75% (in 2012) (ODC 2013), it was increased to 85% during the last two years (in 2014) as recorded in this study. Therefore, the marine conservation program in Tuan Island has been succesfully improved the coral reef condition in this area. This success due to the good support from the local community,

this program is initiated by local fishermen due to the concerns the decline of fish catches in this areas over the years. The fishermen in Aceh Besar district claimed a decreases in fish catches the last few years due to climate change and habitat destruction (Muchlisin et al 2013) and destructive fishing practices, for example using potassium and explosives. Therefore, the fishermen began to realize and initiate to establish of marine conservation (Muchlisin et al 2013). Marine conservation provides some benefit for local people, i.e increase in fisheries productivity and biodiversity, and habitats protection (FAO 2011) and regulate the use of coastal marine resources (Ulloa et al 2013).

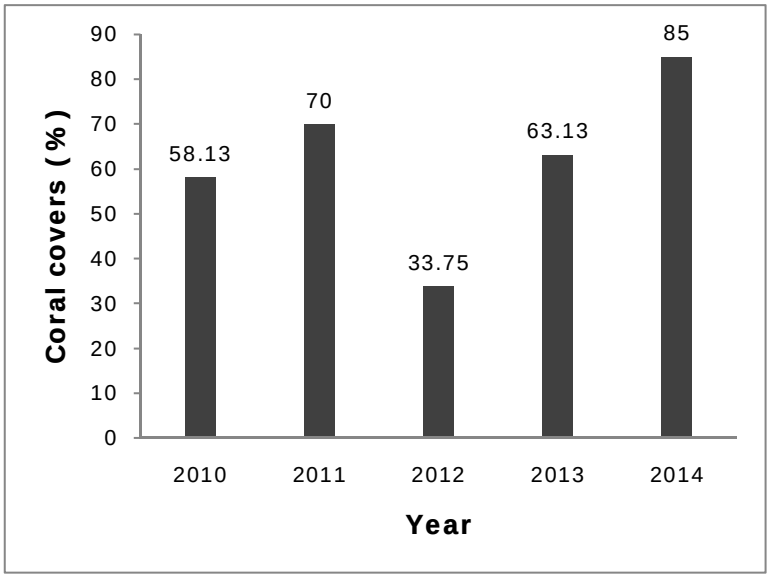

Figure 3. Comparison of the percentage of coral covers from 2010 to 2014 (the data from 2010 to 2013 were collected by the Ocean Diving Club (ODC) of Faculty of Marine and Fisheries, Syiah Kuala University, Banda Aceh, Indonesia; and the data in year 2014 was recorded from this research).

Zonation pattern. Conservation zone of the Tuan Island has initiated by fishermen communities and assisted by local NGOs, for example Lamjabat Foundation, WWF Indonesia and Jaringan KuALA. The program was started in 2010, and legally established in 2012 by the local government of Aceh Besar District. Marine conservation areas are often used as the space management tools to balance harvest pressure on the need, conserve biodiversity and maintain the ecosystem cycles (Noble et al 2013).

The area is divided into 4 zones, i.e., core, buffer, utilization and support zones (Figure 4). This is in accordance with the Regulation of the Minister of Marine and Fisheries of the Republic of Indonesia No. 12/PERMEN-KP/2013, that conservation areas should have several zones i.e. a core zone, limited utilization zone and other zones (Hutabarat et al 2009). The core zone is a restricted zone designated as a protective for coral reef habitat, reef fish and other biota to avoid scarcity on aquatic biota. The buffer zone is a zone designated to protect the core zone and this zone can be used by fishermen to catch fish by using friendly fishing gear that does not damage the coral reef, for example the fishing rod. The utilization zone is provided for fishing activities for traditional fishing practices. In this zone, the fishing communities can catch fish but do not damage the coral reef ecosystem. This is in accordance with the statement of Rotich (2012) that the utilization zone is an area of high conservation value that can tolerate various kinds of human activities. While the support zones designated as zone of protection and support for the well-being of coastal communities whose livelihoods depend on coastal resources, for example fishing practices and eco tourims activities.

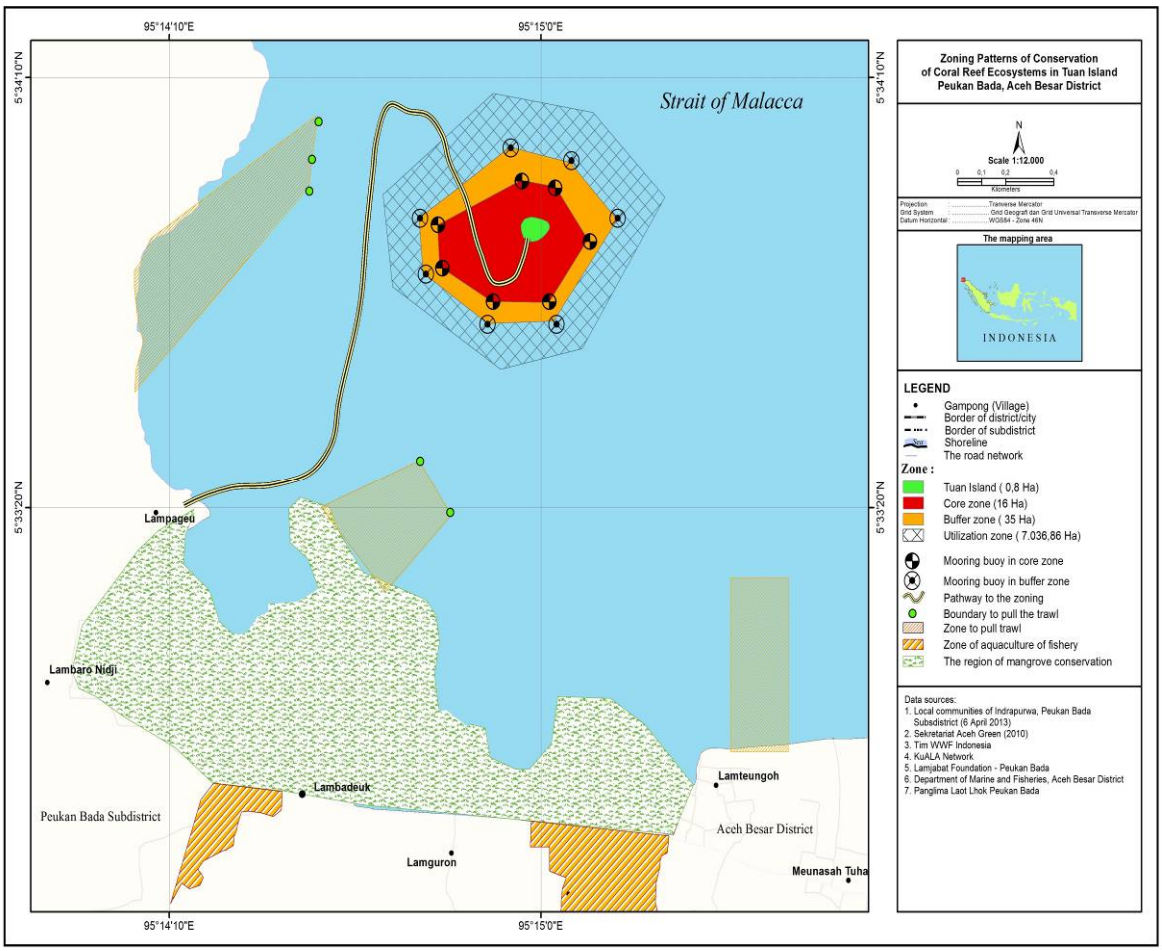

Figure 4. The zonation pattern of conservation area of Tuan Island (derived from various sources, i.e. Jaringan KuALA, WWF Indonesia, Yayasan Lamjabat – Peukan Bada).

The physical condition of waters. The Tuan Island is situated in the Malacca Strait. The physical characteristics of the Malacca Strait have been reported by the several researchers, for example Rizal & Sündermann (1994) discussed the M2-tide in the Malacca strait and its energy balance. Rizal (2000, 2002) concluded that the chance of a real amphidrome produced in high geographical latitude (for e.g., North Sea) is higher than that in low geographical latitude (for e.g., Malacca Strait). And the Malacca Strait has actually virtual amphidromic point, and its position is roughly 2097km away from the middle of the strait to the northeast. Rizal et al (2010) and Rizal et al (2012) described the current simulation in the Malacca Strait and Andaman Sea due to tides, winds, and heat flux. In addition, Rizal et al (2013) collected ocean current data collection carried out by fishermen in Aceh waters and compared it with the ocean modeling results. Chen et al (2014) discussed the importance of wind and tidal circulation in the Malacca Strait. These studies indicate that the Malacca strait is very dynamic ocean and of course gives impact to the aquatic organisms live in this area including corals.

The results showed that the water temperature in the Tuan Island was ranged between 28 to 32°C (Table 2), this is the suitable temperature range for coral. According to Wilkinson & Buddemeier (1994), the optimum temperatures for coral growth are between 23-30°C. However, every coral colony or species has a different resistance in adapting to the temperature fluctuations. According to Grimsditch & Salm (2006), in some cases, the coral has been adapting to stressful environmental conditions and showed physiological tolerance to the high temperatures and UV-radiation that exceeds normal thresholds.

The salinity was between 34 ppt to 38 ppt (Table 2). These values are a normal limit, because the maximum limit for coral growth is between 25 ppt to 40 ppt (Wilkinson

& Buddemeier 1994), the pH range was 7.82-7.92 (Table 2), these pH are the optimum value for corals as stated by Rogers et al (1994). The pH value is caused by the amount of carbon dioxide. An increase in the amount of CO_2 dissolved in the oceans can lower the pH value, and decrease the availability of carbonate ions as an essential mineral in the establishment of the shell (Kleypas et al 2006).

Based on the observation, the highest tide was 1.4 meters, and the lowest tide was 0.55 meters (Table 2). Rising sea levels can provide a larger space for corals to grow upwards. But in general, massive corals are less affected by wave action rather than branching corals. Massive corals grow slowly so it tends to be in the area of large waves, while the smaller coral growing in areas that are sheltered from the waves (CBD 2010).

Table 2

Physical conditions of waters in Tuan Island Peukan Bada, Aceh Besar district. The data was taken at March 16, 2014

Time	*The physical condition of waters*			*Tidal height*
(GMT)	*Salinity*	*Temperature*	*pH*	*(m)*
3:30	36 ‰	28°C	7.89	1.40
4:30	38 ‰	29°C	7.92	1.38
5:30	36 ‰	30°C	7.89	1.30
6:30	34 ‰	31°C	7.82	1.25
7:30	34 ‰	32°C	7.88	0.90
8:30	35 ‰	30°C	7.89	0.60
9:30	35 ‰	28°C	7.89	0.57
10:30	36 ‰	28°C	7.88	0.55

Conclusions. The coral reef condition in the Tuan Island Peukan Bada, Aceh Besar district was in excellent condition at the coral covers of 85% and the zoning patterns of conservation of coral reef ecosystems in Tuan Island consists of 4 zoning patterns i.e. core, buffer, utilization and support zones.

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Authors:
Nadia Aldyza, Department of Biology Education, Graduate School of Syiah Kuala University, Banda Aceh 23111, Indonesia, e-mail: nadia.aldyza@gmail.com
Muhammad Ali Sarong, Department of Biology, Faculty of Teacher Training and Education, Syiah Kuala University, Banda Aceh 23111, Indonesia, e-mail: ali_sarong@yahoo.com
Syamsul Rizal, Department of Marine Sciences, Faculty of Marine and Fisheries, Syiah Kuala University, Banda Aceh 23111, Indonesia, e-mail: syamsul.rizal@unsyiah.net

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